IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Confirmation Number: 8875
Hwa Yaw TAM et al.	Attorney Docket: P71474US0
Serial No. 10/594,068	Group Art Unit: 2613
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For: RAILWAY MONITORING SYSTEM

DECLARATION UNDER 37 C.F.R. § 1.132

I, Siu Lau Ho, am a citizen of Hong Kong and reside at Hong Kong. I am one of the inventors of the above-referenced U.S. patent application Serial No. 10/594,068. I am familiar with the above-referenced U.S. patent application Serial No. 10/594,068 and the references cited by the Examiner including Tubel (U.S. Patent Application Publication No. 2003/0094281 A1) and Varasi et al (U.S. Patent 5,493,390).

A. PERSONAL HISTORY

1. I am currently a Chair Professor of Electrical Utilisation and Head of Department of Electrical Engineering at the Hong Kong Polytechnic University. I have held the former position for 8 years and the latter for 4 years.

2. I graduated from the University of Warwick, U.K. in 1976 with a first class honours degree in Electrical Science. I continued my studies at the University of Warwick and was awarded a PhD in the field of electrical machines in 1979.

3. I joined the then Hong Kong Polytechnic in August 1979 as an Assistant Lecturer and was subsequently promoted to Lecturer in November of the same year. I became a full professor in 1999.

4. I have spent more than 26 of my 32-year academic career working for the railway industry. In Hong Kong I provided consultancy support and analysis to both the Kowloon - Canton Railway Corporation (KCRC) which was subsequently merged with the Hong Kong Mass Transit Railway Corporation (MTR) in 2008. I have also acted as an overseas consultant to Bombardier Inc. for the "Sky Rail" system in Thailand.

5. During my time at the Hong Kong Polytechnic University, in addition to the above-listed consultancy work, I have supervised master and doctorate students working on projects in the field of railway technology.

6. A large part of my consultancy work has been both in the field of railway signaling systems and with systems associated with detection of and monitoring of rolling stock.

7. During my 26 years working for KCRC (now MTR), I was assigned to the investigation of many failure accidents and the like, associated with the railway system. This work included investigations into:

- the earthing problems associated with electromagnetic interferences in railway substations,
- disturbance due to electromagnetic interference of Axle Counters,
- failure of traction motors,
- failure of high tension cables on board trains,
- structural integrity studies of train bodies,
- life extension of rolling stock,
- failure investigation of Circuit Breakers in substations and on board trains,
- voltage transformer failure in substations,
- design improvement of voltage transformers,
- failure investigation of point machines,
- cause of flashover from pantograph to roof top of trains,
- protection relay setting studies,
- planning and replacement of contact wires and overhead lines,
- flashover investigation of surge arrestors,
- cause of excessive vibrations in trains,
- identification of wheel flatness,
- assessment of vacuum circuit breakers,
- assessment of inductors in railway filters,
- evaluation of return currents from traction motors,
- signaling interference problems,
- thermal problems and effects associated with the underframe of trains,
- flashover incidents of voltage transformers on the top of rolling stock,
- failure of traction motor leading to a breaking of overhead power lines
- study into the detection of rail cracks in Hong Kong
- condition monitoring system for the Beijing-Shanghai High Speed Rail in China
- investigation and advice in relation to numerous aspects of railways monitoring and sensor systems,

In essence, I am the "must go to man" whenever there are problems in the railway industry in Hong Kong.

B. Overview of Railway Monitoring and Control Systems

8. A signaling system has been a key component of railway operations for more than 200 years. Its primary purpose is to avoid collision between trains. It was first introduced in the late 18th century with signalmen on the trackside providing hand signals of 'proceed' or 'stop' to train drivers. The first semaphore signal to replace signalmen was erected in 1841. The signaling functionality is divided into two parts: detection of the train in front and relaying corresponding instructions to the train behind. Detection is usually carried out by Track Circuits, which was patented in 1871. The technology for implementation has of course advanced tremendously since that date, however the underlying principle remains: Track Circuits are still

a commonly adopted means of train detection. The axle counter is an alternative approach to train detection in modern-day railway operation. This effectively provides the control of signal indication to train drivers. When the control of a number of signals and corresponding point machines are physically pulled together, overall control can be operated collectively from a distance. This was the initial idea of an interlocking system. The first interlocking installation in the UK was in 1843 and compulsory installation was fully legislated in 1889. Relays and big pneumatic or hydraulic levers were used for the interlocking system in the early 20th century. When microprocessor technology matured in the 1980s, solid-state interlocking became popular and now it is the mainstay technology of interlocking systems that ensure trains do not collide into each other.

9. Train operation monitoring in combination with train control has been in existence for decades, particularly in electrified railway networks with Automatic Train Operation. Modern trains are essentially driverless in that the drivers are not actually driving the trains; they serve as caretakers of the trains in case of emergency. Trains are driven by on-board computers which receive instructions from central computers. The railway network control system is therefore used to detect and control train movement within a network. The detected information must therefore be used not only to maintain adherence to timetables schedules but, critically, to ensure compliance with the stringent safety requirements that are in place to protect trains and passengers carried by trains. It is therefore important for the Central Control Traffic Controller to know the operating condition of each and every train on the network. For these reasons, it is becoming increasingly important to ensure accurate sensing and monitoring of the operation conditions as well as of the operating environments of, in particular, electric trains

10. Over the years, there have been numerous implementations of a remote train network monitoring system. The basic system however includes sensor-type devices for detecting the presence of trains on a train network and communication links for transmitting data output from such devices to a central control system (computer). Numerous sensors are installed at various locations along a rail network, such sensors being designed to detect the presence of a train and, in response, to generate a signal. Typically, sensors are connected to an electrical network, which relays a generated signal to the control system. The collected sensor signals are checked against each other in order to ensure that physical occupation of more than one train on the same section of track is avoided. In response to the information fed back to the central control system, commands can be sent to each train, which can be made to accelerate, coast, decelerate or stop in accordance with requirements. It is of paramount importance therefore that the information provided to the central computer is timely and accurate. Furthermore, a train detection system also provides logistical information in accordance with a timetable. A train monitoring and control system is therefore of critical importance to the safety of a rail network and to the effectiveness of its management.

C. SENSOR DEVELOPMENT

11. Various "sensors" have been utilized in a railway network for train detection. Originally, sensors were of a "contact" type which, when triggered by mechanical interaction with a train, for example, engagement with a wheel, generated an electrical signal to indicate the passing of a train at a particular point in the network.

12. Current sensors for railway monitoring networks are, and have been for the past 30 years or so, "non-contact" sensor types. Generally these are of an electrical/electrode mechanical nature that, when in the vicinity of rolling stock, have their electrical properties altered in some way. This variation is used to provide an indication of the presence of a train at the location of the sensor. Numerous varieties of non-contact sensors have been suggested and used over the years. These include sensors based on:

- the piezo-electric effect
- eddy-current and hysteresis detection from exposure to the wheel of rolling stock,
- field deflection methods, which alter the alternating current in ferro-magnetic materials, which in turn is detected by a receiving coil,
- inductive methods in which the inductance of a sensing coil is altered by the presence of ferro-magnetic materials in the wheel of rolling stock in the vicinity,
- resonant circuits provided adjacent rails which interact with a transponder on a train so as to provide the time and location of the train,
- radio frequency (RF) systems that include a transmitter and receiver located along the rail such that an RF transmission between the transmitter and receiver is interrupted by the wheel of rolling stock passing along the track.

13. There is now an increasing demand for a smart sensory network which can detect more than simply the passage of a train. Such a smart network can provide information as to the weight of trains, the powering condition of trains (i.e. whether it is drawing power, regenerating or coasting), possible derailment dangers, indication of passenger comfort (i.e. whether the trains are running with uncomfortable jerks). Such data can, of course, be used to ensure, ideally, a fast and safe journey for all train riders. However there is no commercial system which can be used to detect all the parameters as mentioned with a single system. Hitherto there is one system for each purpose. There is Axle Counter system, there is anti-derailment system, there is wheel flatness detection system, but all these systems do not talk to each other. Even for a single system such as Axle Counters, it is common to have one track equipment set (CTS) to look after one set of sensor as it is perceived to be "safer" to have a modular system to facilitate simple repair/replacement. In other words, if there is failure in one sensor, the technician should be able to replace that single sensor/sub-component/sub-system easily and readily without affecting other sensor/sub-component/sub-system so as to provide the highest degree of safety. The Hong Kong Polytechnic University is now working at an advanced stage of development with MTR with an objective to produce a commercial system to realize all the sensing functions as mentioned for railway operators around the world.

D. ASSOCIATED EQUIPMENT: THE CTS

14. Regardless of the detail of the sensors used, all the above types, when implemented within a train monitoring network, provide a signal to indicate the presence of rolling stock at the sensor location. The signal is often locally processed at the remote location by way of a code track equipment set (CTS). Each CTS is associated with a particular portion of train line and it may monitor several sensors in that region. Data from spaced-apart sensors provide an indication of the direction of travel of rolling stock within the train network. The signals from the local CTS units are relayed to the central or local monitoring substation, originally by means

of rail side telegraphic wire. The development of signal transmission means and devices has lead to other methods and manners of transmitting or relaying the signals provided by the sensors. Such means include dedicated signal transmission line, telegraphic railway stations, and RF transmission to repeater stations, substations or the like.

15. It is also necessary to provide electrical power to local CTS units and, in the most common implementations using RF or inductive sensors, to hardware associated with railway monitoring sensors. For electrical rail systems, electricity may be obtained from the rail network. In areas that have a local electricity supply, electrical power may be obtained from a local grid. However, for remote sensors, in particular those utilized in networks that do not operate with electricity but rather networks in which the rolling stock is powered by fuels such diesel, there is often no local supply of electricity available. Thus, in such remote locations, it is necessary to provide either a dedicated electrical supply system to the sensors, thus increasing infrastructure costs, or a local power supply that may be recharged by, for example, solar power.

E. DESIGN CONSIDERATIONS

16. Safety is paramount. Data collected and transmitted must be accurate. Sensors and the CTS must be reliable and robust.

17. A railway network is large, often covering vast distances through isolated locations. Installation of a network monitoring system requires a high capital investment in the infrastructure: sensors and CTS must be installed throughout and a source of electrical power in some locations.

18. Railway networks are exposed to extreme temperatures and conditions throughout the world, including temperatures as low as -45°C, and with rails reaching temperatures of up to 90°C in a hot environment. Rails may be exposed to variations in temperatures as well as to extreme weather conditions of high humidity, snow, ice and rain, that present a hostile environment. Large amount of strain may be induced in rails by such environmental conditions to the extent that buckling can occur. Similarly, the environment to which a sensor is subject following its placement in a railway network imposes significant design implications for railway engineers. The sensors must remain reliable in a hostile environment.

19. Sensors in a railway network are remotely located and often in isolated areas. It is important that such sensors require minimal maintenance and incorporate a "fail-safe" feature in order that monitoring at an isolated location is not compromised by failure of a sensor.

20. Similar considerations apply to the CTS and to the electrical power supply to the sensors and CTS units. The power supply system must be reliable and have fail-safe provisions: critical to the ability to monitor accurately or to reinstate a railway network after monitoring system failure.

21. Additional problems apply to a railway network having electrically powered trains, either by way of a third rail or overhead High Tension wires. A significant and problematic amount of electromagnetic radiation (EMR) is present as a result of the electricity supply, which may cause electromagnetic interference (EMI) to sensors and local CTS data acquisition and monitoring

units. EMI can affect amplifiers and processing units within CTS units, as well as the CTS transmission hardware and/or software which relays information obtained from sensors back to the central control system. Furthermore, EMI may interfere with transmission of signals received from a sensor and transferred to a CTS, or signals received by a CTS that are forwarded to a central or local monitoring station. If the track is electrically powered, there may be thousands of amperes flowing along the rail, and this may also give rise to EMI, which impacts upon the integrity of data acquired from sensors, data processed at local CTS units, as well as transmission of data from the CTS units to the central railway monitoring system.

22. EMI may also arise from the trains themselves, both electrical and diesel powered, which also can affect the integrity of data transmission from sensors and CTS units, and so interfere with reliability of data.

23. Lightning from electrical thunderstorm activity also presents a hazard that can provide sporadic interference with and even lead to failure of a railway network monitoring system. Such sporadic interference is a well-known cause of loss of data integrity in a railway monitoring system to an extent that a railway network needs to be shut down. If corrupt data leads to the position of rolling stock being unknown at the central monitoring system, then the network must be shut down for safety reasons. A train passenger will observe that in a thunderstorm, the trains are not permitted to move in the normal manner. Under such abnormal conditions, trains may have to move at very low speeds, typically 20 to 25 km/hr, in order to ensure there is sufficient time to stop the train if the driver sees another train ahead.

24. Electrical power supplies to CTS units and to sensors may be interfered with by stray EMI, in particular that generated by thunderstorm activity.

25. It is accordingly necessary to provide appropriate protection, to the extent possible, in relation to sensors, processing units, CTS units and any power supplies in the network.

26. Another significant safety issue that arises from EMI, in particular that from overhead 25 kV High Tension lines, is that it induces voltages and currents within signal transmission lines between sensors, CTS units and monitoring stations. Voltages generated have been found to be of the order of 600 volts, which poses serious safety considerations to railway network technicians and engineers when working upon railway monitoring systems. It is apparent that although voltages and currents utilized for signal transmission may be relatively low and safe, the spurious voltages generated by stray EMI pose a significant occupational health and safety issue. Investment in either the training of technicians and engineers as well as in safety implementations, where appropriate, is required in order to reduce the likelihood of injury or death from currents generated within signal transmission wiring control.

F. HISTORICAL DEVELOPMENTS

27. As noted above, sensors in particular are subject to extreme environmental conditions. This, coupled with the large economic and stringent safety issues associated with train monitoring, has resulted in many different types of sensors and variations thereof being tried and tested over the years. Improvements in manufacturing processes, environmental insulation and the like, have also been applied in order to develop sensors that are sufficiently reliable for use in

a railway monitoring system. Development has been focused on improvements to sensors and to the capability of sensors within the existing railway networks, as a consequence of the large capital expenditure and infrastructure investment already in place following establishment of the system. Such development, as noted above, is driven by the paramount importance of reliability, consistency and fail-safe provisions in the railway monitoring network.

28. Similar improvements have also been seen in the processing of signals generated by the sensors. Whilst traditionally railway sensors have been of an analogue type design, the evolution of computer processing technology and hardware has lead to a situation in which analogue signals are now utilized within analogue and digital monitoring networks. Electrical signal processing techniques have evolved to enable increased responsivity and accuracy within a control and monitoring system. Similar advancements have been made to computer-controlled monitoring of rolling stock and to fault detection/diagnosis using analogous/digital sensors. Within the last 40 years, there has in fact been significant innovation to the railway monitoring system, leading to the emergence of many proprietary products with enhanced reliability and accuracy. For example, improved means to connect sensors to rail, increased fail-safe and return signaling hardware.

29. Despite the many technical advances made, for example introducing a redundancy system for normal and predictable interference levels in a system, the only safe solution to high interference levels, for example those caused by thunderstorms, requires the shutting down of a train network or allowing the trains to move manually at an unacceptably low speed. The control system may be reset or "reinitiated" to allow the positions of rolling stock within the network to be determined and adjusted from a central or local control station. The cost however is a significant time delay that causes significant inconvenience and economic loss to a railway network, as well as social implications with passengers not arriving on time at their destinations.

30. There are many designs of sensors available on the market today. Each design is responsible for a specific application, such as anti-derailment systems, axle counting, train speed measurement, vibrating monitoring system. The majority of these however use conventional passive devices, which are subject to electromagnetic interferences. Optical devices have been proposed as replacement for their inductive/capacitive/RF counterparts, but to the best of my knowledge these have not been implemented in a working network system.

31. In my experience, railway engineers do not turn to innovative concepts when they encounter problems *in situ*. For example, when the railway engineer encounters serious interference problems with wired sensors, he will look to provide improved insulation. With the increasing use of mobile phones, it was observed that their operation in the vicinity of electronic circuitry can lead to serious disruptions in signalling systems. The solution was to introduce safety provisions such as grounding of systems in order to mitigate against the infiltration of unwanted noises into the railway control circuit. My own solution to the problem of engineer safety as a result of potentially high voltages and currents induced in signalling circuits by EMI was to recommend to KCRC that signaling engineers are required to possess an acceptable licence to equip them with sufficient knowledge to guard against potential electric hazards.

32. Despite the myriad advances in technology since the introduction of railway monitoring and control systems, present networks still operate along the same basic lines. The monitoring systems can be characterised by a series of sensors installed at known locations within a rail network, the sensors being connected to local CTS units or directly to a signal transmission network, and a centralized or monitoring station, such that the presence of trains at particular locations is known for rail network management and safety control.

G. MOTIVATION TO COMBINE

33. It is respectfully submitted that those skilled in the art would not have found it obvious to use fiber Bragg gratings to modify the Tubel's invention in order to arrive at the presently claimed invention, on the basis that there is no teaching, suggestion or motivation to combine the cited references.

34. It would be apparent that the main focus of the Tubel's invention is to use distributed sensors based on technologies different from fiber Bragg grating. In particular, Tubel explicitly proposes using following scattering techniques whereby stress and strain on rails may be detected, namely "Rayleigh, Brillouin, and Raman scattering techniques" (see paragraph [0115]) to measure the railroad conditions to address the inadequacy of discrete sensors, including fiber Bragg gratings, for railroad condition measurements. In other words, Tubel was not aware of the potential power of Fibre Bragg grating in solving the problem of detecting rail stress and train positions in a cost-effective manner.

35. Although Tubel also vaguely stated that "other techniques used to obtain information as the light reflects as it travels in and out of fiber optic cable 20" (see paragraph [0115]), apparently those skilled in the art would not readily ascertain that fiber Bragg gratings may be used.

36. Even though the person skilled in the art would look for other examples, they would not find it obvious to use fiber Bragg gratings to modify the Tubel's invention. For instances, Tubel states that "Reliability can be improved if no sensors 32 are deployed in rail 302, using reflected photons from the light traveling into fiber optic cable 20 instead" (see paragraph [0116]). Tubel also states that "The advantage of this latter embodiment over the use of single point or distributed downhole sensors 32 (such as the Bragg grating sensors 32 described in the aforementioned patents) is improved reliability, lower cost as well as more precise measurements". Based upon these references, it would be apparent that those skilled in the art would be taught away from using fiber Bragg grating for monitoring conditions of the railway.

37. Furthermore, when reading Tubel in which Bragg gratings are explicitly proposed in other embodiments but not in the embodiment for railway application, those skilled in the art would have taken the view that Bragg gratings may not be preferable in the railway monitoring system other than Rayleigh, Brillouin, and Raman scattering techniques as explicitly discussed and proposed. That is, although fiber Bragg grating is being mentioned in other embodiments of Tubel, Tubel has in fact positively discouraged those skilled in the art to use fiber Bragg grating for monitoring the conditions of railway infrastructure.

38. The prevailing practice of railway engineers in railway monitoring systems is of a conservative nature, and due to large amounts of infrastructure in existence for which the reliability and the acceptability within industry standards has over a long period of time gained acceptance, due to the onerous safety requirements which dictates high levels of reliability as well as redundancy measures.

39. A railway engineer, as demonstrated throughout the prior art and in relation to modern day technologies, utilizes the implementation of railway monitoring system technology and infrastructure in existence, as such equipment is interfaced within a network in a manner which has been tested over a long period of time and reliability and confidence in such a system has been established.

40. Upon reading of Tubel, a railway engineer would identify the system as described as being that typical, tried, tested and established in the art. Without any inference or hint in Tubel that Bragg gratings could provide any enhanced advantage in comparison with those as described with reference to the preferred embodiment, a railway engineer would unlikely be motivated to use Bragg gratings in preference to those described in relation to the embodiment of Fig. 5.

41. Given the prejudice in the field against the introduction of new technologies and the extreme conservative mindset, particular there prejudice against the use of relatively "fragile" sensors such as Fibre Bragg grating sensors, it would appear that a railway engineer would not find it obvious to implement Bragg gratings in the embodiment of Fig. 5 of Tubel's invention, when there is no express indication that Bragg gratings are particularly suitable to railway monitoring systems or has been tried and tested in a railway environment. In this regard, although Varasi states that the invention therein may be applicable to "ground transportation", "railway", the absence of clear examples as to how the optical sensors can be implemented in railway systems raises doubt as to why those skilled in the art would be motivated or find it obvious to replace the optical sensors of Fig. 5 of Tubel with Bragg gratings.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patents issuing thereon.

EXECUTED at 17:00 hours this 3rd day of March, 2011.

By ______________________

Siu Lau Ho

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